Chapter Two

Estimates of Future Superfund Costs

The Congressional Budget Office analyzed three scenarios for Superfund costs after 1992, reflecting present levels of uncertainty about the size of the remaining cleanup problem. The base-case estimate is $74 billion in discounted, present-worth dollars; the low-case and high-case estimates are $42 billion and $120 billion, respectively. Annual undiscounted costs in the base case peak at $9.1 billion in 2003 and average $2.9 billion per year through 2070.

A major factor in these estimates is the assumed number of sites on the National Priorities List; the assumptions of 2,300 nonfederal NPL sites in the low case, 4,500 in the base case, and 7,800 in the high case explain most of the differences in estimated costs. Other assumptions that have a major impact on costs are those regarding the average cleanup costs per NPL site and the discount rate. The cost estimates are less sensitive to assumptions about removal actions, site studies, administrative activities, and legal costs.

Overview of the Methods for Estimating Costs

CBO's estimates of future Superfund costs include site-based costs for study and investigation, cleanup, and enforcement combined with federal nonsite costs for program administration and private transaction costs. To reflect the time value of money and important uncertainties about the determinants of future costs, the estimates are given in discounted, present-worth dollars and for three scenarios based on alternative sets of assumptions.

The basic idea underlying the estimates can be expressed in a simple formula:

Total costs = [(number of sites) x (average cleanup cost + average investigation and study cost + average enforcement cost)] + private transaction costs + federal program costs.[1]

Because different types of sites have vastly different average costs, however, it is useful to extend this formula by distinguishing between NPL sites, non-NPL removal sites, and sites evaluated for possible inclusion on the NPL. This extension avoids the use of a single, overall per-site cost that could be unreliable as a basis for extrapolating into the future. As discussed later in this chapter, vastly different costs can also be found within the set of NPL sites; accordingly, CBO further distinguishes three cost categories of NPL sites--"mega-," "major," and "minor" sites--to explore possible changes in the mix of sites and their implications for average cleanup costs.

1. Private transaction costs and federal program costs could also be analyzed in terms of average costs per site. As explained later in the chapter, however, the CBO analysis treats transaction costs as a markup on other responsible-party costs rather than as a fixed cost per site, and it models program costs as a mixture of per-site costs, annual costs, and markup rates.

The CBO analysis also goes beyond the simple formula in taking account of the year in which a cost is incurred, so as to permit the calculation of discounted, present-worth costs. In measuring the overall impact of a multiyear stream of benefits or costs, economists view dollars spent or gained in the future as less valuable than present dollars, for two reasons that correspond to supply and demand factors. First, later dollars are easier to supply, in that one dollar can be invested now to return more than one dollar in the future. Second, present dollars are in greater demand, in that individuals generally prefer not to delay gratification, all other things being equal. Accordingly, the estimates reported here use an annual discount rate to roll back the entire stream of future costs into an equivalent 1993 present worth.[2]

The CBO estimates reflect a mix of data and informed opinion. Where possible, CBO based its assumptions on regularities and trends identified in the Superfund program to date that seem likely to apply to the future. Because data on the many categories of site-specific and non-site-specific costs are often scarce or unreliable, however, many assumptions could only be based on subjective judgments reached in consultation with informed sources.

The necessity of subjective judgments prompted CBO to develop alternative scenarios in which it could vary key assumptions. The low and high cases are intended to represent plausibly optimistic and pessimistic scenarios of Superfund costs, capturing between them most of the relevant range of uncertainty. Although the resulting estimates do not provide a statistical 90 percent confidence interval, CBO believes that future costs are unlikely to lie far outside their span.

The Cost Estimates

The CBO estimates of future Superfund costs are $42 billion in the low case, $74 billion in the base case, and $120 billion in the high case.[3] These present-worth estimates are calculated using a 7 percent annual discount rate, and they exclude the costs associated with cleaning up federal facilities. They also assume no major changes in policy or breakthroughs in technology; estimates that reflected those additional sources of uncertainty would span a wider range.

The present-worth estimates depend not only on the total dollars spent but also on the pattern of spending over time. In the absence of funding constraints, the base and high cases project that annual costs will rise severalfold through the year 2003 and then decline more gradually. The sharp increases reflect both timely progress of existing NPL sites through the cleanup process and a tripling or quadrupling of the size of the NPL, partly driven by an assumed backlog of sites in the last stage of the Environmental Protection Agency's screening process. Estimated spending increases in the low case are much more moderate and short-lived.

Responsible parties pay more than half of total costs in all three scenarios; the federal government's share is between 36 percent and 40 percent of the total, and the state share does not exceed 5 percent. By spending category, site studies and cleanup account for most of the costs, with remedial actions at NPL sites alone accounting for half of the total. Enforcement and transaction costs together represent just under one-quarter of total costs.

Nationwide Costs in Total and Over Time

The base-case estimate of $74 billion is closer to the low-case figure of $42 billion than to the high case's $120 billion. This reflects a comparable asymmetry in the assumed numbers of ultimate NPL sites--4,500 in the base case compared with 2,300 in the low case and 7,800 in the high case. (See Appendix A for a summary of the different assumptions underlying the cases.) As discussed later in the section about site

2. For a more detailed discussion of discounting, see Robert C. Lind, "A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options," in Robert C. Lind, ed., *Discounting for Time and Risk in Energy Policy* (Washington, D.C.: Resources for the Future, 1982).

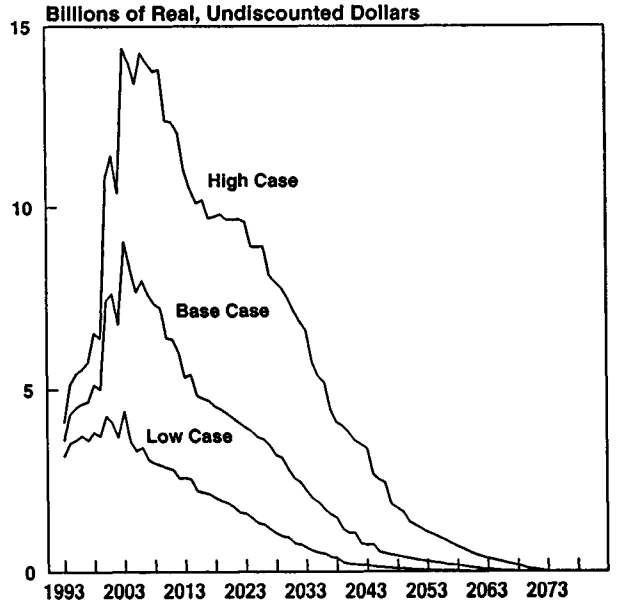
3. As used in this study, future "costs" (or "spending" or "expenditures") generally refer to obligations--that is, funding commitments made at the beginning of a one-year or multiyear project. The only ongoing outlays resulting from obligations before 1993 that are included in the estimates of future costs are those for operations and maintenance of site cleanup projects. Because of their 24-year duration, O&M costs are tracked as outlays in CBO's analysis.

assumptions, the range of plausible numbers of NPL sites is less clearly defined at the high end than at the low end; this greater uncertainty warrants an asymmetrically high number of NPL sites in the high case.

Annual spending in real (that is, inflation-adjusted) but undiscounted dollars peaks in the year 2003 in all three scenarios, as shown in Figure 2. The height of the peak varies dramatically, however--from $4.4 billion in the low case to $9.1 billion in the base case and $14.4 billion in the high case. (For comparison, 1992 obligations were roughly $3 billion.) The paths shown in Figure 2 assume that funding is not constrained; the consequences of constraints on the growth of Superfund are considered in Chapter 3.

The rapid growth in estimated spending in the base and high cases is largely fueled by rapid growth in the National Priorities List, which adds 2,181 new nonfederal sites by the year 2003 in the base case and 3,378 new sites in the high case. Roughly one-third of the additions represent sites brought to EPA's attention for screening after 1992; the other two-thirds are drawn from the 11,000 sites that began but did not finish the screening process by the end of 1992, of which 6,400 were in the final, "decision-pending" stage. The assumptions of the base and high cases imply that the decision-pending group includes substantial backlogs of sites--roughly 900 and 1,400, respectively--awaiting placement on the NPL.[4] Given adequate funding for cleanup work at both new and existing sites, the number of projects rises sharply. The average number of remedial investigations/feasibility studies started annually from 1993 through 2003 is estimated to be 339 in the base case and 490 in the high case, whereas the actual average between 1990 and 1992 was 115. Over the same period, the average number of new remedial actions reaches 243 a year in the base case and 291 in the high case, compared with 109 in the 1990-1992 period.

Figure 2.
Total Superfund Expenditures, Fiscal Years 1993-2075



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

Cumulatively, the costs shown in Figure 2 total $106 billion in undiscounted dollars in the low case, $228 billion in the base case, and $463 billion in the high case. Costs are incurred through 2062, 2070, and 2075, respectively; hence, average annual costs in undiscounted dollars are $1.5 billion, $2.9 billion, and $5.6 billion. These averages have only limited significance: because of the necessary sequencing of cleanup activities, total future costs cannot be paid out in equal yearly installments. Averages excluding the final 24 years of spending (during which all remaining cleanup projects are assumed to be in the operations and maintenance phase) are roughly 40 percent to 50 percent higher--$2.3 billion, $4.2 billion, and $7.7 billion, respectively.

Costs by Payer and Category

CBO estimates that responsible parties will pay 58 percent of total present-worth costs in the base case (roughly $43 billion out of $74 billion), with the government paying 38 percent ($28 billion) and the

4. No significant backlog exists in the low case; as discussed in the next section, this case assumes a lower value for the percentage of screening sites ultimately placed on the NPL.

states paying 4 percent ($3 billion), as shown in Table 3. These figures reflect costs as initially paid; subsequent cost recoveries that would increase the RP share further and decrease the federal share are not estimated here. Also, the estimated costs to state governments cover only their required contributions to "fund-lead" cleanup projects (those performed by EPA); state or local government contributions to "enforcement-lead" cleanups (those performed by responsible parties) resulting from liability for individual Superfund sites are included in the estimate for costs to liable parties.

These shares vary only a few percentage points in the other scenarios. In the high case, two factors increase the share paid by responsible parties to 60 percent and decrease the federal share to 36 percent. First, the larger number of NPL sites makes cleanup costs a larger fraction of overall spending, and these cleanup costs are concentrated among the responsible parties. Second, as discussed later in the chapter, CBO's analysis assumes that private cleanups cost less than those conducted by the government, but the assumed advantage is smaller in the high case than in the base case. Conversely, the same two factors also explain why the RP share falls to 55 percent in the low case.

When base-case costs are measured in undiscounted dollars, the responsible parties pay 61 percent of the total, the federal government 31 percent, and the states 8 percent. The state share of total costs in undiscounted dollars is twice the present-worth figure because discounting has a larger impact on costs that are more distant in time and state costs are primarily for operations and mainte-

Table 3.
Future Superfund Costs, by Initial Payer (In present-worth and undiscounted dollars)

Payer	Base Case		Low Case		High Case	
	Billions of Dollars	Percent	Billions of Dollars	Percent	Billions of Dollars	Percent
	Present Worth, Discounted at 7 Percent					
Responsible Parties	42.5	58	23.2	55	72.4	60
Federal Government	28.1	38	16.9	40	42.8	36
State Governments[a]	3.3	4	2.1	5	5.0	4
Total	73.9	100	42.2	100	120.1	100
	Undiscounted					
Responsible Parties	139.1	61	61.2	58	295.8	64
Federal Government	69.9	31	35.0	33	130.2	28
State Governments[a]	19.2	8	9.8	9	36.8	8
Total	228.3	100	106.0	100	462.9	100

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

a. State contributions to fund-lead cleanups only. Contributions to RP-lead cleanups at sites where state or local governments share direct liability are included in the figures for responsible parties.

nance, which occur at the end of the cleanup process. RP expenditures are similarly back-loaded, although not to the same extent, and therefore also represent a larger share of the total in undiscounted dollars.

By expenditure category, base-case costs of removal and remedial cleanup plus site investigation and study represent about 64 percent of future Superfund costs in present-worth dollars (with remedial action alone accounting for 53 percent); enforcement and transaction costs account for 24 percent; and federal costs for support activities, research, and general management make up the remaining 11 percent (see Table 4). The share

Table 4.
Future Superfund Costs, by Category (In present-worth and undiscounted dollars)

Category	Base Case		Low Case		High Case	
	Billions of Dollars	Percent	Billions of Dollars	Percent	Billions of Dollars	Percent
Present Worth, Discounted at 7 Percent						
Site Studies and Cleanups						
Remedial actions	39.1	53	22.4	53	65.6	54
Other	8.5	11	4.4	11	13.8	12
Subtotal	47.6	64	26.8	64	79.4	66
Enforcement	4.5	6	2.5	6	6.6	5
Transaction Costs	13.4	18	7.7	18	21.6	18
Support Activities	3.7	5	2.6	6	4.9	4
Research and General Management	4.7	6	2.6	6	7.7	6
Total	73.9	100	42.2	100	120.1	100
Undiscounted						
Site Studies and Cleanups						
Remedial actions	134.0	59	61.1	58	281.3	61
Other	17.9	8	7.8	7	35.3	7
Subtotal	151.9	67	68.9	65	316.6	68
Enforcement	10.7	5	4.9	5	19.5	4
Transaction Costs	43.8	19	20.2	19	88.3	19
Support Activities	10.4	5	6.7	6	15.8	3
Research and General Management	11.4	5	5.3	5	22.7	5
Total	228.3	100	106.0	100	462.9	100

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

accounted for by enforcement and transaction costs does not support the belief that most Superfund money is being devoted to negotiation and litigation, but is consistent with CBO's analysis of spending through 1992.[5]

The share of costs going to study and cleanup is slightly greater in the high case--again, because the number of sites is larger and average cleanup costs per site are higher--or when measured in undiscounted dollars, which give greater weight to O&M costs. The share of study and cleanup costs is lower in the low case than in the base case when costs are measured in undiscounted dollars, but the two are essentially equal in present-worth dollars, despite the smaller number of NPL sites in the low case. These facts reflect the timing of the various expenditures. Because fewer sites are added in the future, the existing NPL sites--many of which have already passed the study and investigation stages--take on greater relative importance. On average, therefore, cleanup costs occur earlier in the stream of overall costs in the low case than in the base case.

Assumptions About Numbers of Sites

The ultimate numbers of NPL sites, non-NPL removal sites, and screening sites are highly uncertain. The significance of this uncertainty lies in the fact that the number of NPL sites is a key determinant of Superfund's long-run costs. Accordingly, this study reports estimates based not only on a base case of 4,500 nonfederal NPL sites--almost four times the current level of 1,149 sites--but also on alternative scenarios of 2,300 sites and 7,800 sites (twice and roughly seven times the current level).

CBO derived these figures by combining estimates of the number of screening sites brought to EPA's attention as candidates for cleanup with estimates of the fraction of these sites accepted by the NPL screening process. In each scenario, a second rate was applied to the same pool of candidate sites to estimate the number whose contamination problems will be found not to warrant placement on the NPL but to be serious enough to require removal action.

Other assumptions determined the incidence of future NPL mega-sites (defined here as those for which the records of decision estimate cleanup costs of $50 million or more) and distributed sites between the fund-lead and RP-lead categories. These assumptions influence the estimates of average cleanup costs per site--in the latter case, because the analysis also assumes that the private sector has some efficiency advantage over the government in performing cleanups.

Number of Screening Sites

CBO's base case assumes that 25,394 new sites will be brought to EPA's attention for screening, in addition to the 36,814 sites already known to the agency at the end of fiscal year 1992. The low and high scenarios assume 15,151 and 50,000 additional screening sites, respectively.

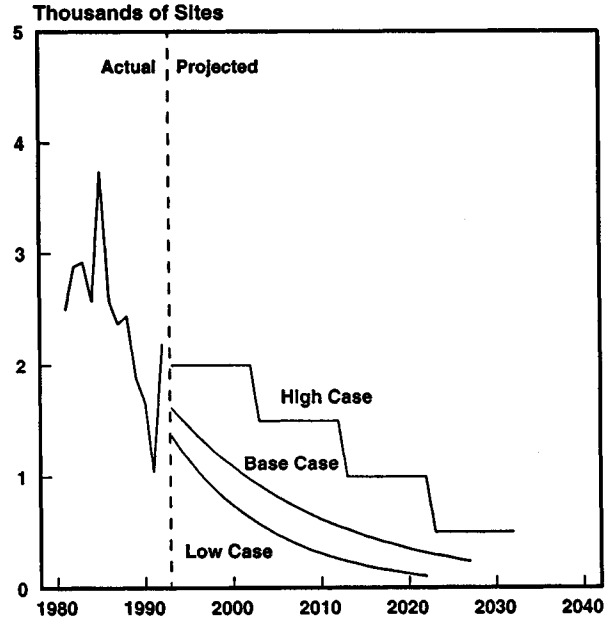
These assumptions are based on alternative interpretations of the Superfund experience to date. Annual additions to the screening inventory between 1981 and 1992 ranged from a high of 3,737 in 1985 to a low of 1,043 in 1991 (see Figure 3).[6] The evidence suggests an overall downward trend--particularly when the 1981-1986 additions are compared with those from 1987 to 1992--but its strength cannot be reliably determined from the handful of data points.

5. EPA data suggest that enforcement spending accounted for roughly $0.9 billion through 1992. As noted in Chapter 1, CBO estimates that private-sector transaction costs over the same period were $2.0 billion. Hence, total enforcement and transaction costs were on the order of $2.9 billion, or 22 percent of the estimated $13.4 billion spent by the public and private sectors.

   The enforcement and transaction costs considered here include most but not all of the out-of-pocket costs resulting from Superfund's liability system. Not included are certain of EPA's nonenforcement expenses, such as the extra costs it incurs to obtain litigation-quality data in its site studies.

6. EPA also had 8,000 sites in its screening inventory at the end of fiscal year 1980. CBO does not know why additions to the inventory were so high in 1985 or so low in 1991; explanations would have to be sought at the level of the state governments, the primary channels through which EPA becomes aware of new sites.

Figure 3.
Actual and Assumed Additions to the Superfund Screening Inventory



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

The base-case estimate of 25,394 additional screening sites was derived by fitting a curve to the 1981-1992 data and extrapolating it to the year 2027.[7] The cutoff point in 2027 was chosen as a subjective correction for the indefinitely long "tail" of the curve; it can also be interpreted as a year by which the flow of new sites will be small enough to be handled by something other than the present Superfund program. The low-case figure of 15,151 sites resulted from fitting a similar curve to the data from the latest six years (1987 to 1992) and extrapolating it to the year 2022. The rationale behind this alternative is that the more recent data may better indicate the program's likely future course. Finally, the high case assumes a slower decline in screening sites (in a stepwise pattern chosen for simplicity), with 50,000 new sites added to the inventory by the year 2032. This case implies a total of 86,814 sites, counting those already identified, which is roughly consistent with a draft EPA analysis that estimated a total of 91,000 sites most likely to need evaluation.[8]

The number of screening sites is important to the estimate of total Superfund costs primarily because of its impact on the assumed numbers of NPL and removal sites. As discussed in the section about cost assumptions, screening costs themselves are assumed to be relatively minor in this analysis, averaging less than $46,000 per site. Consequently, a 10 percent increase in the number of future screening sites alone, holding constant the NPL and removal sites, would add less than 0.1 percent to total present-worth costs in any of the three scenarios.

Number of NPL Sites

Converting the size of the screening inventory to the size of the National Priorities List requires estimating the fraction of screening sites that will ultimately be placed on the NPL. According to a rough estimate from knowledgeable Superfund staff, the future placement rate will be in the neighborhood of 5 percent to 10 percent. Unfortunately, existing data are not useful in refining this estimate. EPA revised its screening criteria in March 1991, and too few data have accumulated since then to allow the estimate to be confirmed or narrowed.

The results under the original screening criteria are not useful either. First, the revised criteria may not yield the same overall acceptance rate as their predecessors. Second, the data on the performance

7. With the data smoothed using a three-year moving average, the resulting exponential-decay curve was 1,714*exp(-0.056593*[t - 1992]), where t indicates the year. The result in the low scenario, discussed next, was 1,497*exp(-0.087737*[t - 1992]); data smoothing was not required for a good fit in this case.

8. Environmental Protection Agency, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, "The Superfund Universe Study: Interim Report" (September 30, 1991). The estimate includes 58,000 sites in the "Focused Screening Universe," defined as those sites in categories representing "the highest priority for possible site discovery and screening efforts," and roughly 33,000 sites already in the inventory as of February 1991. An additional 9,000 sites thought to be of low hazard potential bring a more general "Superfund Evaluation Universe" to an estimated total of 100,000 current and future sites.

of the original criteria are distorted because EPA deferred final decisions on thousands of sites during the transition to the new system. As of the end of 1992, 3.5 percent of all sites that had entered the inventory were listed on the NPL, but another 18 percent were in the decision-pending stage, having survived the earlier preliminary assessment and site inspection phases, and 15 percent awaited either the PA or SI.

In the absence of firmer information, CBO chose placement rates of 8 percent in the base case, 5 percent in the low case, and 10 percent in the high case. All three scenarios assume that federal facilities, whose costs are excluded from the analysis, continue to represent 10 percent of all NPL sites. Multiplying these placement rates by the above projections of total screening sites, subtracting 10 percent for federal facilities, and rounding to the nearest hundred sites yields the estimates of 4,500 nonfederal NPL sites in the base case, 2,300 in the low case, and 7,800 in the high case.[9]

The difference in assumed NPL size between the low case and base case (2,200 sites) is notably smaller than the difference between the high case and base case (3,300 sites), reflecting the fact that the range of possible sizes is more clearly defined at the low end than at the upper end. It is relatively easy to argue that the ultimate number of nonfederal NPL sites is unlikely to be much below 2,300. Observed acceptance rates suggest that even if no more sites were added to the screening inventory, the National Priorities List would reach 2,400 sites just on the basis of the 11,000 incomplete sites in the inventory at the end of 1992.[10]

The estimates of total present-worth costs are highly sensitive, though not strictly proportional, to the numbers of NPL sites; a 10 percent increase in the assumed level implies cost increases of roughly 7 percent in all three scenarios. The main reason that estimated costs rise less than 10 percent is an issue of timing: the increase in ultimate NPL sites shifts the "center of gravity" of Superfund expenditures farther into the future (since near-term costs include those for sites already on the NPL), thus reducing the impact on present-worth costs.[11]

The variation in assumed size of the NPL is the main cause of the differences in the scenarios' estimated costs. Modifying the base case by adopting the NPL size assumptions from the low case would reduce its estimated present-worth costs by $25 billion--80 percent of the difference between the two scenarios. Similarly, substituting the high-case NPL would raise base-case costs by $38 billion, eliminating 81 percent of the difference in present worth. The assumed differences in average cleanup costs and ancillary activities account for the remaining differences in estimated costs.

NPL Sites by Cost Category

To varying degrees, each of the three scenarios assumes that the average costliness of remedial cleanups falls as more sites are added to the NPL. The rationale for this downward trend is the theory that a disproportionate number of the worst problems were discovered and listed in the early years because of their obviousness and that the program will increasingly be "scraping the bottom of the barrel" as additional sites are listed.[12]

9. The base-case calculation yields (36,814 + 25,394)*0.08*0.90 = 4,479 ≈ 4,500; the low scenario gives (36,814 + 15,151)*0.05*0.90 = 2,338 ≈ 2,300; and the high scenario gives (36,814 + 50,000)*0.10*0.90 = 7,813 ≈ 7,800.

10. Focusing on nonfederal sites, 8,903 sites had reached the site inspection stage and completed the screening process by the end of 1992, of which 1,149, or 12.9 percent, were placed on the NPL. Applying this percentage to the 9,040 sites awaiting the SI and those in the post-SI decision-pending stage yields 1,167 new NPL sites. Counting the sites that never received a site inspection because they were screened out at the preliminary assessment stage, the overall acceptance rate through 1992 was 4.8 percent (1,149 NPL sites out of 24,119 final decisions); applying this rate to the 2,064 sites awaiting the PA yields an additional 98 NPL sites.

11. In undiscounted dollars, which are unaffected by timing, the increase ranges from 9.2 percent to 9.4 percent in the three scenarios. The other factors contributing to the divergence from strict proportionality are that the costs of screening and removals at non-NPL sites are unaffected by the change in NPL size; that some EPA support costs rise less than proportionately; and that the added sites have lower average cleanup costs than their predecessors as a consequence of the "barrel-scraping effect" discussed in the next section.

12. An extension of this argument would suggest that all NPL-caliber contamination problems, not just the worst of the worst, should get scarcer over time, and thus that the rate at which screening sites are

Assumptions about the strength of this barrel-scraping effect can have a significant impact on estimates of long-run costs. If the base case had assumed a fixed distribution of NPL sites by cost category, its present-worth estimate would have been $84 billion; hence, the arguably conservative level of barrel scraping actually used in the scenario lowers costs by 12 percent. Plausible steeper trends in the distribution of sites would have larger impacts.

The key fact that makes the barrel-scraping effect an important issue is that some Superfund NPL sites can be hundreds of times more "super" than others in terms of their cleanup costs (see Box 2). Indeed, evidence suggests that the most expensive 10 percent of sites have accounted for 50 percent of all cleanup costs, and the least expensive half of sites have represented only 10 percent of total costs.[13] If this wide distribution of NPL cleanup costs is likely to continue relatively unchanged, then estimates of future costs need only extrapolate from the average per-site cost observed so far. If not, however, then changes in the composition of the NPL also must be taken into account.

The available data suggest that the distribution of NPL sites is changing. In particular, the incidence of so-called mega-sites appears to be declining. Defining a mega-site as one with cleanup costs of $50 million or more (as estimated in the records of decision), EPA staff know or expect 44 of the 711 nonfederal sites proposed for the NPL through October 1984 to be mega-sites, a ratio of 6.2 percent. The same can be said of only 0.9 percent (4 of 438) of the nonfederal sites proposed since 1984.

The significance of the apparent drop in the incidence of mega-sites is hard to determine now, for three reasons. First, part of the fall could be illusory, if some recent sites have not yet received enough attention for EPA staff to know of their true costliness, or if changes in EPA policies have divided some potential mega-sites into multiple pieces for listing purposes. Second, the net impact on future cleanup costs of any barrel-scraping trend could be reduced by a possible second effect acting in the opposite direction. This second effect assumes that early "false-positive" mistakes in the screening process led to the listing of a comparatively high number of inexpensive sites not containing NPL-caliber problems and thus artificially lowered the average costs observed to date. Third, a current barrel-scraping effect could conceivably be reversed in the future if a category of mega-sites is newly discovered or gets increased attention. Large areas contaminated with mining wastes may prove to be such a category.[14]

Although conclusive data are not available, CBO considers it likely that a significant barrel-scraping effect is reducing average cleanup costs and will continue to do so. In light of the current uncertainty, the three scenarios analyzed here employ different assumptions about the strength of the effect, with all three erring on the conservative side by assuming less barrel scraping than the limited data suggest. The analysis distinguishes three cost categories of sites on the NPL: mega-, major, and minor sites, defined as those with estimated present-worth costs of $50 million or more, between $20 million and $50 million, and less than $20 million, respectively.

The assumed decline in mega-sites and major sites occurs most rapidly in the low case and most

placed on the NPL should fall. If there exists a large pool of "lesser" potential NPL sites that are no more obvious than the average site with less-than-NPL-caliber contamination, however, then any such reduction in the placement rate might be delayed for many years or be of limited magnitude.

13. This pattern is observed in two partly overlapping samples of NPL sites: one sample, developed by EPA, mixes partial and complete estimates of construction costs at 253 nonfederal sites; the other, developed by researchers at Resources for the Future, includes complete estimates of inflation-adjusted cleanup costs (including operations and maintenance costs) at 168 sites. Outside the Superfund context, EPA also found 10 percent of sites accounting for one-half of total costs in an analysis of 79 waste treatment and disposal facilities subject to corrective action cleanups under the Resource Conservation and Recovery Act; see Environmental Protection Agency, "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units" (March 1993), p. ES-12.

14. A recent Congressional report indicated that the Department of the Interior has just begun surveying its lands for mining sites needing cleanup or reclamation; see House Committee on Natural Resources, Subcommittee on Oversight and Investigations, "Deep Pockets: Taxpayer Liability for Environmental Contamination," Majority Staff Report (July 1993). The report said that the number of abandoned mine sites on Interior lands may be in the hundreds of thousands, but it did not estimate the number needing significant cleanup or the average cost per site. Such sites contribute to the total national bill for cleanup but not the Superfund bill, since their costs are borne by the Interior Department and responsible private parties.

Box 2.
Examples of Mega-, Major, and Minor Sites

Mega-site: The 22-acre Whitmoyer Laboratories site in Jackson Township, Pennsylvania, is in a largely agricultural area. Portions of the site are in the 100-year floodplain of the Tulpehocken Creek, and an estimated 20 residences in the vicinity use the underlying aquifer for drinking water.

Whitmoyer produced organic compounds containing arsenic on the site between 1957 and 1964. In 1964, widespread groundwater contamination was discovered, leading the owners to place concentrated wastes in a concrete vault and start a pump-and-treat operation to clean the groundwater. Sludge from the groundwater treatment was placed in on-site lagoons in 1977. In 1986, the Environmental Protection Agency (EPA) discovered arsenic contamination in nearby wells and began providing residents with bottled water. The last owners abandoned the site in 1987.

EPA divided the cleanup work at the site into three operable units. The first dealt with 69,000 gallons of concentrated liquid wastes in tanks and pipes near the creek; the second addressed roughly 29,000 cubic yards of vault and lagoon wastes and miscellaneous chemicals remaining on the site, plus contaminated buildings and equipment; and the third focused on 116,000 cubic yards of contaminated soil and sediment and the contaminated groundwater. The remedies selected by EPA involved demolition, excavation, off-site thermal or biological treatment, on-site incineration and fixation, groundwater treatment (physical, chemical, and possibly biological), capping, and off-site and on-site disposal. Estimated present-worth costs for the three operable units totaled $124 million, which qualifies the site as a mega-site for purposes of the Congressional Budget Office's (CBO's) analysis.

Major site: The Northside Landfill occupies 345 acres in a mixed residential and agricultural area of Spokane, Washington. One-third of the site lies over a large aquifer that serves the Spokane-Coeur d'Alene area.

The landfill began accepting residential and light commercial refuse from the city of Spokane and other public and private haulers in the 1930s, and it was still in use when EPA completed its record of decision in 1989. Investigations in 1981 and 1983 revealed the presence of volatile organic compounds beneath the site and in residential wells northwest of it. The city responded by supplying the 19 affected residences with bottled water and then extending municipal water lines to the area.

The remedy EPA selected for the site included closing and capping the landfill's four disposal areas, pumping and treating the groundwater until closure of the landfill reduces contamination below target levels, and implementing institutional controls to restrict access to the site and prevent construction of wells that would draw on contaminated water. The cost estimate for this remedy was $30 million, placing the site in CBO's "major" cost category.

Minor site: The Vogel Paint and Wax site is a two-acre disposal area, part of an 80-acre tract outside Maurice, Iowa. Adjacent land use is primarily agricultural. An aquifer beneath the site supplies private wells and the Southern Sioux County Rural Water System.

Paint sludge, resins, solvents, and other wastes from paint manufacturing were disposed of at the site between 1971 and 1979. Records indicate that roughly 43,000 gallons of organic chemicals and 6,000 pounds of metal wastes were buried in trenches during this period. The owner covered the disposal area with a clay cap in 1984.

EPA's chosen remedy for this site included either biological or thermal treatment of 3,000 cubic yards of contaminated soil; off-site incineration, recycling, or disposal of the wastes themselves; groundwater pumping and treatment using air stripping; and monitoring of the air and groundwater. With an estimated cleanup cost of less than $1.9 million, this site is a minor site in CBO's classification.

SOURCE: Adapted from Environmental Protection Agency, *ROD Annual Report*, various years.

gradually in the high case (see Table 5). Nonetheless, the low case has the highest overall proportion of mega-sites because the smaller number of NPL sites in that scenario gives the barrel-scraping effect less of an opportunity to take hold.

The three scenarios also differ in the proportions of major and minor sites among the first 711 nonfederal NPL sites. Cost estimates for many of these sites remain incomplete, making it impossible to know exactly how many will end up in each category. (Estimates for many early mega-sites are also incomplete, but the greater notoriety of these sites allows their number to be specified more precisely. All scenarios assume that mega-sites constitute 6.5 percent of the first 711 sites, or 46 sites in all,

Table 5.
Assumed Distribution of NPL Sites, by Cost Category (In percent)

	Mega-Site	Major Site	Minor Site
	Base Case		
First 711 Sites	6.5	18.7	74.8
Next 989 Sites	4.0	13.0	83.0
Next 1,200 Sites	2.0	8.0	90.0
Next 1,600 Sites	2.0	6.0	92.0
All 4,500 Sites	3.1	10.1	86.8
Total Number of Sites	141	454	3,905
	Low Case		
First 711 Sites	6.5	14.0	79.5
Next 789 Sites	4.0	10.0	86.0
Next 800 Sites	2.0	6.0	92.0
All 2,300 Sites	4.1	9.9	86.0
Total Number of Sites	94	227	1,979
	High Case		
First 711 Sites	6.5	23.3	70.2
Next 1,189 Sites	5.0	20.0	75.0
Next 1,600 Sites	3.5	16.5	80.0
Next 4,300 Sites	2.0	12.0	86.0
All 7,800 Sites	3.2	15.2	81.7
Total Number of Sites	247	1,184	6,369

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are $50 million or more; for major sites, between $20 million and $50 million; and for minor sites, less than $20 million.

See Appendix A for the differences in assumptions underlying the three cases.

NPL = National Priorities List.

thereby building in a small cushion of two additional cases on top of the 44 already identified.) Based on data on 273 cleanup projects at 253 nonfederal sites, the base case here assumes that 20 percent of the non-mega-sites (or 18.7 percent of all sites) in these early cohorts will be major sites; the low and high cases use 15 percent and 25 percent for this ratio, respectively.

Non-NPL Removal Sites

All three scenarios assume that 7 percent of the sites in the screening inventory ultimately become nonfederal non-NPL removal sites (those requiring limited or emergency, but not long-term, cleanup). This assumption is an extrapolation of experience to date. Of all sites that had begun the screening process, the fraction that were nonfederal non-NPL sites with one or more removals started was 5.8 percent in 1992, up from 5.4 percent in 1991 and 4.8 percent in 1990.[15] The upward trend in recent years suggests that the ultimate percentage of non-NPL removal sites may exceed 7 percent; however, many of the sites included in the current 5.8 percent may later be reclassified as NPL sites.

The reason for using the same assumption in all scenarios is not that this percentage is known with precision, but that the uncertainty is relatively unimportant to the estimates of total costs. A 10 percent increase in the number of future non-NPL removal sites would add no more than 0.3 percent to projected present-worth costs in any of these scenarios.

The use of NPL placement rates of 5 percent to 10 percent, compared with an assumption of 7 percent for non-NPL removal sites, does not imply that the national total of "modest" waste problems that could be handled through EPA's removal authorities is similar to, or even less than, the number of NPL-caliber problems. Many of the simpler problems are resolved by private voluntary action or by state agencies rather than through the federal Superfund program.

Sites by Lead Party in Cleanup

This analysis also classifies cleanup projects at NPL and non-NPL sites as RP leads or fund leads--that is, as performed (and paid for) by the responsible parties under EPA supervision, or directly by EPA. The division of projects by lead party obviously affects the distribution of costs between the public and private sectors; it may also affect the cost total if, as many observers believe, the private sector can perform the same work less expensively than EPA.[16]

The distributions of lead parties assumed in this analysis vary by type of cleanup or study project, but they do not vary by scenario. Based on the results observed in the first three years of EPA's enforcement-first policy, CBO's analysis assumes that responsible parties will take the lead in 25 percent of future removal projects at non-NPL sites, 40 percent of removals at NPL sites, 50 percent of remedial investigations/feasibility studies, and 70 percent of remedial designs and remedial actions. Total costs in the three scenarios are not strongly sensitive to these percentages. Raising the RP-lead share for RDs and RAs from 70 percent to 75 percent reduces costs by 1.5 percent in the low case, where the assumed private-sector cost advantage is the largest, and less in the other cases--provided that private transaction costs do not change as a result of the increase in RP leads. Depending on the relative contentiousness of RP-lead cleanups and of cost-

15. More precisely, 2,031 non-NPL sites other than federal facilities had started one or more removals by the end of 1992, and 34,793 federal and nonfederal sites had received at least a preliminary assessment (the first stage of the screening process) or a prescreening removal.

16. A report released after CBO completed its analysis provides some support for this belief. The report, commissioned by the Department of Energy, compared 58 "environmental restoration" (ER) cleanups conducted by the department with 233 other public and private cleanup projects. Statistical analysis correcting for differences in such factors as volume of waste, contaminated media, and cleanup technology indicated that the ER projects cost 15 percent more than the other government cleanups (including fund-lead Superfund cleanups) and 32 percent more than the private cleanups. These findings imply that private-sector costs are 13 percent lower than those in the (non-ER) public sector, within the range of the CBO assumptions given in Table 8. See Department of Energy, Office of Environmental Restoration and Waste Management, "Project Performance Study" (prepared by Independent Project Analysis, Inc., Reston, Va., November 1993), pp. iii-v.

recovery efforts after fund-lead cleanups, changes in transaction costs could supplement, reduce, or even reverse the direct savings.

The share of remedial actions undertaken by EPA is a key determinant of future costs to the states. As noted in Chapter 1, state governments provide 10 percent of the capital costs of all fund-lead RAs and bear all the associated costs for operations and maintenance (except the first 10 years of costs for a pump-and-treat remedy for groundwater).[17] CBO's assumptions about the types, costs, and durations of O&M projects imply that states pay 54 percent of the public sector's present-worth costs for O&M (using a 7 percent discount rate), or 72 percent of the costs measured in undiscounted dollars. The present-worth share is lower because discounting gives greater weight to the front-loaded federal contributions.

Assumptions About Direct Response Costs

Estimated costs for direct response--that is, for site-specific screening, study, and removal and remedial action--constitute the lion's share of total Superfund costs in all scenarios, with the share ranging from 64 percent in the low case to 66 percent in the high case. In turn, costs for remedial action (major cleanup) at NPL sites represent the large majority of all direct response costs--82 percent or more in the three cases. Consequently, assumptions about average RA costs are second in importance only to those about the number of NPL sites in terms of their impact on total estimated costs.

The analysis described below led CBO to assume that costs for fund-lead remedial actions in the base case are $169 million for each mega-site, $50 million for each major site, and $21 million for each minor site, with RP-lead cleanups costing 20 percent less for all three types of sites (see Table 6).[18] These assumptions yield an average cost of $25 million for the 4,500 NPL sites (or roughly $28 million, before the 20 percent RP-lead savings). Several factors make these estimates uncertain. In recognition of this uncer-tainty, the low and high scenarios make alternative assumptions that, when coupled with the distributions of site types shown in Table 5, result in average costs per site of $23 million in the low case and $29 million in the high case.

The estimates of total Superfund costs are sensitive to the assumptions about average RA costs. For example, a 10 percent increase in the assumed RA costs for major NPL sites would raise total costs by 1.4 percent in the base case, as shown in Table 7, and an increase in the private-sector efficiency advantage from 20 percent to 25 percent of EPA costs would reduce total expenditures by 3.6 percent.

The average costs per site for non-RA cleanup and study are both less uncertain (because the data are more plentiful and less variable) and less important to an estimate of overall Superfund costs (because non-RA costs are small relative to RA costs). Consequently, CBO's analysis used the same cost assumptions for non-RA response activities in all three scenarios:

Site Screening	
Preliminary assessments	$10,000 per site
Site inspections	$65,000 per site
Removals	$600,000 each
Remedial Investigations/ Feasibility Studies	$1.2 million each
Remedial Designs	$1 million each

17. Based on data from EPA and researchers at Resources for the Future, CBO assumed that 47 percent of remedial actions involve contaminated groundwater; that present-worth O&M costs for groundwater remedies average 4.7 times those for other cleanups (at the 10 percent discount rate commonly used in EPA's records of decision); and that O&M continues for 30 years in groundwater cases and 20 years in all others.

18. These average costs appear inconsistent with the cost ranges used to define major sites (between $20 million and $50 million) and minor sites (below $20 million). The definitions are based on cleanup costs as estimated in EPA's records of decision; the averages used in this analysis incorporate information on cost growth after the ROD estimates.